LASER INDUCED FLUOROMETRY/CONE PENETROMETER (LIF) DEMONSTRATION PLAN

LASER INDUCED FLUOROMETRY/CONE PENETROMETER

TECHNOLOGY DEMONSTRATION PLAN

at the

HYDROCARBON NATIONAL TEST SITE

Naval Construction Battalion Center Port Hueneme, California

Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY

Office of Research and Development

Environmental Monitoring Systems Laboratory-Las Vegas

Consortium for Site Characterization Technology

Prepared by:

NAVAL COMMAND, CONTROL AND OCEAN SURVEILLANCE CENTER

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NAVAL COMMAND, CONTROL AND OCEAN SURVEILLANCE CENTER

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REVIEWS AND APPROVALS

ADDENDUM TO THE

LASER INDUCED FLUOROMETRY/CONE PENETROMETER

TECHNOLOGY DEMONSTRATION PLAN

We, the undersigned, have read and approve of the attached Addendum to the Laser Induced Fluorometry/Cone Penetrometer Technology Demonstration Plan.

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FOREWORD

The Consortium for Site Characterization Technology (CSCT) has established a formal program to accelerate acceptance and application of innovative monitoring and site characterization technologies that improve the way the nation manages its environmental problems. The consortium is a partnership program involving the U.S. Environmental Protection Agency (EPA), the Department of Defense, and the Department of Energy to support the demonstration and verify the performance of new and emerging technologies. The consortium, in collaboration with the Naval Command, Control and Ocean Surveillance Center, Research, Development, Test, and Evaluation (NCCOSC RDT&E) Division, will demonstrate two configurations of an in situ laser-induced fluorescence (LIF)-based field screening technology using the Site Characterization and Analysis Penetrometer System (SCAPS) cone penetrometer testing (CPT) platform. The data generated during the demonstration are intended to verify the performance of the LIF technologies for real-time in situ field screening of petroleum hydrocarbons in subsurface soil at hazardous waste sites and to establish acceptance by the EPA and user community.

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The LIF sensing technologies to be demonstrated using the SCAPS CPT platform have been developed through a collaborative effort of the Navy, Army, and Air Force under the Tri-Service SCAPS Program. The LIF techniques have been developed for real-time in situ subsurface field screening of petroleum hydrocarbons. A suite of sensors is being developed for use with CPT platforms. The SCAPS CPT and its family of sensors will be capable of providing rapid, in situ, subsurface measurements of many different types of contaminants.

The technology demonstration using: (1) the SCAPS LIF sensor and support system developed and provided by the NCCOSC RDT&E Division, and (2) the Rapid Optical Screening Tool (ROST), developed by Unisys Corporation, will be conducted at the Hydrocarbon National Test Site located at the Naval Construction Battalion Center (NCBC) Port Hueneme, California, to analyze the physical characteristics of soil and chemical characteristics of petroleum hydrocarbon contamination at an aboveground storage tank fuel farm. The SCAPS LIF and ROST technologies will be deployed concurrently, but evaluated separately during the demonstration.

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EXECUTIVE SUMMARY

The Consortium for Site Characterization Technology (CSCT) has established a formal program to accelerate acceptance and application of innovative monitoring and site characterization technologies that improve the way the nation manages its environmental problems. CSCT is a partnership program involving the U.S. Environmental Protection Agency (EPA), the Department of Defense (DOD), and the Department of Energy (DOE) to support the demonstration and verify the performance of new and emerging technologies. The consortium, in collaboration with the Naval Command, Control and Ocean Surveillance Center, Research, Development, Test, and Evaluation (NCCOSC RDT&E) Division, will demonstrate two configurations of a laser-induced fluorescence (LIF) sensor technology using the Site Characterization and Analysis Penetrometer System (SCAPS) cone penetrometer testing (CPT) platform to facilitate their acceptance and use for the field screening of petroleum hydrocarbons in the subsurface.

This technology demonstration plan is intended to ensure that demonstration activities are documented and scientifically sound, and that performance data of known quality are collected. NCCOSC RDT&E Division has prepared this technology demonstration plan following the guidelines in EPA's Environmental Monitoring Systems Laboratory (EMSL) document, "Guidance Manual for the Preparation of Site Characterization Technology Demonstration Plans - Protocol I, version 3.0," dated December 25, 1994. The data generated during the demonstration are intended to verify the performance of the SCAPS Laser-Induced Fluorescence (LIF) sensor and support system developed and provided by the NCCOSC RDT&E Division and the Unisys Corporation Rapid Optical Screening Tool (ROST) LIF systems for field screening of petroleum hydrocarbons in subsurface soil at hazardous waste sites and to establish acceptance by EPA and the user community.

Technology Description

The LIF technologies to be demonstrated using the SCAPS CPT platform provide real-time field screening of the physical characteristics of soil and chemical characteristics of petroleum hydrocarbon contamination at hazardous waste sites. The current configuration is designed to quickly and cost-effectively distinguish hydrocarbon-contaminated areas from uncontaminated areas. Secondary to this primary attribute is the acquisition of geologic information, reduction of investigation derived waste, and other benefits. This capability allows further investigation and remediation decisions to be made more efficiently and reduces the number of samples that must be submitted to laboratories for analysis.

The LIF sensing technologies to be demonstrated using the SCAPS CPT platform have been developed through a collaborative effort of the Navy, Army, and Air Force under the Tri-Service SCAPS Program. The LIF systems to be demonstrated use a pulsed laser coupled with an optical detector to measure fluorescence via optical fibers. The measurement is made through a sapphire window on a probe that is pushed into the ground with a truck-mounted CPT. CPT and standard penetrometer testing (SPT) have been widely used in the geotechnical industry for determining soil strength and soil type from measurements of tip resistance and sleeve friction on an instrumented probe. The two LIF technologies to be demonstrated are (1) the nitrogen laser-based LIF sensor and support system currently being used in the Navy, Army, and DOE (developed by the Navy's NCCOSC RDT&E Division in collaboration with the Army's Waterways Experimental Station and Army Environmental Center [AEC]), the SCAPS and (2) a tunable dye laser-equipped induced fluorescence system, the ROST (developed through a collaborative effort by the Air Force, Dakota Technologies Inc., and Unisys Corporation).

The LIF methods provide data on the in situ distribution of petroleum hydrocarbons from the fluorescence response induced in the polycyclic aromatic hydrocarbon (PAH) compounds that are components of the petroleum hydrocarbon. The methods detect PAHs in the bulk soil matrix throughout the vadose, capillary fringe, and saturated zones. The methods provide a "detect/non-detect" field screening capability relative to a specified detection limit derived for a specific fuel product on a site-specific soil matrix. The methods also provide qualitative data derived from spectrographic data at depths up to 150 feet.

Demonstration Objectives and Approach

The primary objectives of this demonstration are to evaluate the SCAPS and ROST LIF technologies in the following areas: (1) their performance compared to conventional sampling and analytical methods; (2) the logistical and economic resources necessary to operate the technologies; (3) data quality; and (4) the range of usefulness in which the technologies can be operated. Performance of the SCAPS LIF and ROST LIF will be evaluated to determine the percentage agreement between LIF "detect/non-detect" data and both total recoverable petroleum hydrocarbons (TRPH; EPA Method 418.1) and total petroleum hydrocarbons (TPH; Department of Health Services [DHS] Method 8015-Modified) results above or below the SCAPS LIF and ROST LIF detection thresholds. Secondary objectives for this demonstration are to evaluate the LIF technologies for their reliability, ruggedness, cost, range of usefulness, data quality, and ease of operation.

The demonstration is designed to evaluate the LIF technologies as a field screening method by comparing LIF data to data produced by conventional sampling and analytical methods. For the demonstration, conventional sampling and analysis will consist of overboring LIF push holes with a hollow stem auger, collecting split spoon samples as close as possible to the push cavities, and analyzing discrete samples for petroleum hydrocarbons by EPA Method 418.1 and California Department of Health Services (DHS) Method 8015-modified. The demonstration objectives will be achieved by collecting data during two phases of sampling: (1) predemonstration sampling, and (2) demonstration sampling.

Site Description

The LIF demonstration will be conducted at the Hydrocarbon National Test Site located at Naval Construction Battalion Center (NCBC) Port Hueneme, California, using the two LIF technologies to analyze the physical characteristics of soil and chemical characteristics of the petroleum hydrocarbon contamination that occurred following a release of hydrocarbons at an aboveground storage tank fuel farm. The study area, Site 22, was chosen because the soils are known to have been affected by petroleum hydrocarbon releases of diesel fuel marine (DFM). The underlying groundwater is shallow, with a slight gradient toward the south. The preliminary data from the site indicate the presence of soils contaminated with total petroleum hydrocarbon concentrations in excess of 70,000 milligrams per kilogram.

A second demonstration site may be selected to provide additional LIF performance data from an arid environment with deep groundwater (greater than 80 feet below land surface). A separate addendum to the technology demonstration plan will be prepared if an additional demonstration site is selected.

LIST OF ABBREVIATIONS AND ACRONYMS

AEC Army Environmental Center

ASTM American Society for Testing and Materials

ATI Analytical Technologies, Inc.

bbl Barrel (Equivalent to 42 U.S. Gallons)

cm Centimeter

CAS Chemical Abstract Service

CPT Cone Penetrometer Testing

CSC Computer Sciences Corporation

CSCT Consortium for Site Characterization Technology

DFM Diesel Fuel Marine

DHS Department of Health Services (California)

DOD Department of Defense

DOE Department of Energy

DOT Department of Transportation

DQO Data Quality Objective

EDM Engineering Development Model

EMMC Environmental Monitoring Management Council

EMSL Environmental Monitoring Systems Laboratory

EnTICE Environmental Technology Innovation, Commercialization, and Enhancement (Program)

EPA Environmental Protection Agency

ETI Environmental Technology Initiative

ft Feet

ft/ft Feet per Foot

FVD Fluorescence Versus Depth

FY Fiscal Year

GC/FID Gas Chromatagraph/Flame Ionization Detector

HASP Health and Safety Plan

HNTS Hydrocarbon National Test Site

HSA Hollow Stem Auger

Hz Hertz

IDW Investigation Derived Waste

IR Installation Restoration

IRP Installation Restoration Program

ITER Innovative Technology Evaluation Report

LIF Laser-Induced Fluorescence

m Meter

m Micrometer

mg/kg Milligrams per Kilogram

mg/L Milligrams per Liter

mJ Millijoules

mL Milliliter

mm Millimeter

m/min Meters per Minute

ms Millisecond

msl Mean Sea Level

NCBC Naval Construction Battalion Center

NCCOSC RDT&E Naval Command, Control, and Ocean Surveillance Center Research, Development, Test, and Evaluation (Division)

nm Nanometer

NRaD Unofficial Shorthand Abbreviation for NCCOSC RDT&E Division

NS Nanosecond

PAH Polycyclic Aromatic Hydrocarbons

PDA Photodiode Array

PE Performance Evaluation

PM Program Manager

PPE Personal Protective Equipment

ppm Parts per Million

PRC PRC Environmental Management, Inc.

QA Quality Assurance

QAPP Quality Assurance Project Plan

QC Quality Control

R^2 Correlation Coefficient

RAB Restoration Advisory Board

RI/FS Remedial Investigation/Feasibility Studies

ROST Rapid Optical Screening Tool

SCAPS Site Characterization and Analysis Penetrometer System

SNL Sandia National Laboratories (Department of Energy)

SOP Standard Operating Procedure

SPT Standard Penetrometer Testing

TER Technology Evaluation Report

TPH Total Petroleum Hydrocarbons

TPM Technical Project Manager

TRPH Total Recoverable Petroleum Hydrocarbons

TSF Tons per Square Foot

U.S. United States

USCS Unified Soil Classification System

Unisys Unisys Corporation

UV Ultraviolet

WES Waterways Experimental Station (Army Corps of Engineers)

WTM Wavelength Time Matrix

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